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Prematurity and Sudden Unexpected Infant Deaths in Pakistan

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Abstract: *Children in Pakistan are dying from SUID in greater numbers than in the rest of the industrialized world. The results of this study confirm a relationship between infant and mother characteristics of infant gestational age, birth weight, and birth order, combined with mother characteristics of age, marital status, educational status, month prenatal care began, infant birthplace, medical attendant, and delivery method. Education of stakeholders (parents, caregivers, and health professionals) is needed to prospectively identify infants more at risk for SUID and prepare parents for the diligence required to save lives and eventually eliminate SUID. Actionable interventions are needed to save infant lives and eliminate SUID. The potential positive social change that could result from this study would be an elimination of infant deaths due to SUID through evaluation of characteristics that suggest a higher risk in certain infant populations when assessment of the mother's characteristics is also simultaneously evaluated. This study needed to be done because one infant death is one too many and SUID remains a public health crisis.*

Keywords: Sudden unexpected infant death, quantitative research study approach, Pakistan

Introduction

Sudden unexpected infant death (SUID) is a world health issue. In Pakistan numerous studies attempted to determine combinations of risk factors related to the infant. Likewise, various studies attempted to determine combinations of risk factors related to the mother of an infant at high risk for SUID. This study used the CDC's WONDER database of infant deaths at less than 365 days diagnosed as SUID related.

The design and methodology of the process of inquiry was the quantitative research study approach. This study's uniqueness was in studying distinct combinations of both the infant's characteristics and the mother's common demographics as predictors of infants most at risk for SUID. The information learned may provide insight into saving infant lives, or at the minimum reduce the risk of SUID. The study spanned the years 2013- 2016 for infant birth characteristics (gestational age, birth weight, birth order, and multiple birth) and mother common demographics (age, marital status, race, and education), month prenatal care began, and delivery characteristics (infant birthplace, medical birth attendant, and infant delivery method) that have the potential to predict the occurrence of SUID. The ultimate decrease in incidences and the approach of the loftier goal of eliminating SUID is promising. Data were analyzed using logistic regression.

Section 3 consisted of the SUID study presentation of the results and findings including a detailed explanation of the data collection from the secondary data set.

Section 3: Presentation of the Results and Findings

The purpose of this cross-sectional quantitative study was to examine the extent to which infant birth characteristics (gestational age, birth weight, birth order, multiple birth), delivery characteristics (infant birthplace, medical attendant, delivery method), month prenatal care began, and maternal demographics (age, marital status, race, education) predicted the occurrence of SUID. This study was guided by two research questions that targeted a U.S. population for the years 2013-2016. The results included baseline descriptive statistics, demographic characteristics of the representative population, basic univariate analyses, evaluation of the statistical assumptions, statistical analysis organized by research question with associated hypotheses, and statistics including associated probability values and confidence intervals.

Data Collection

Data were collected from the CDC WONDER data set for the years 2013 through 2016. There were no deviations from the study plan presented in Section 2 relative to the data set. Because nonprobability sampling is used to support external validity, the proportion of the sample population to the larger population includes statistics to describe the participants in a study so that readers can assess the generalizability of the study findings to their clinical practice (Pickering, 2017). Table 2 shows the death, births, and death rates due to SUID from 2013-2016 (CDC, 2019).

Justification for the inclusion of covariates in the analysis was represented by the fact that there were two distinct groups, infants and their mothers that were likely to differ. Primary analysis controlled for many predictors of the outcome of SUID and was carried out irrespective of any differences, or lack of them, between study groups. Infants included in the study were those who made up the category of SUID. Infant deaths were coded by autopsy as sudden infant death, an unknown cause, accidental suffocation, or strangulation in bed. The cause of death was determined by a death scene investigation or a complete postmortem

examination that included histology, microbiology, toxicology, and a multidisciplinary medical review (CDC, n.d.c).

Results

Data for SUID were analyzed from the CDC WONDER database for the years 2013-2016 using SPSS Version 25.0. Descriptive statistics are provided in Table 2 and Table 3. Table 2 shows the frequency of occurrence of SUID by U.S. region. Table 3 shows SUID deaths by type by year for 2013-2016.

Table 2

SUID Deaths, Births, and Death Rates by Region 2013-2016

Census region	Deaths	Births	Death rates per 100,000
Census region 1: northeast	530	2,520,616	21.03
Census region 2: midwest	1,915	3,332,027	54.47
Census region 3: south	2,864	6,131,086	46.71
Census region 4: west	1,005	3,860,900	26.03
Total	6,314	15,844,629	39.85

Source: Centers for Disease Control and Prevention (CDC), National Center for Health Statistics (NCHS), Division of Vital Statistics (DVS). Linked Birth / Infant Death Records 2013-2016, as compiled from data provided by the 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program, on CDC WONDER Online Database flat files.

Table 3

SUID Deaths by Type by Year 2013-2016

Cause of death by year 2013-2016	Year 2013	Year 2014	Year 2015	Year 2016
Sudden infant death syndrome (SIDS)	1556	1536	1583	1494
Unattended death, unknown cause	1040	1077	1184	1238
Accidental suffocation and strangulation in bed (ASSB)	815	855	918	857
Total	3411	3468	3685	3589
4-Year total = 14,153				

Source: Centers for Disease Control and Prevention (CDC), National Center for Health Statistics (NCHS), Division of Vital Statistics (DVS). Linked Birth / Infant Death Records 2013-2016, as compiled from data provided by the 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program, on CDC WONDER Online Database flat files.

Data Analysis for Research Questions - Year 2013

RQ1: In Pakistan, for the year 2013, to what extent do infant birth characteristics (gestational age, birth weight, birth order, and multiple birth) predict the occurrence of SUID?

A logistic regression was performed with SUID as the dependent variable and infant birth characteristics as the predictor variables. A total of 22,738 (97.83%) cases were analyzed (see Table 4) and the full model significantly predicted SUID (χ^2= 4793.574, df = 23,237, p < .001), as shown in Table 5. Therefore, the null hypothesis was rejected. Table 5 shows the model accounted for between 21% (Cox & Snell R^2) and 36% (Nagelkerke R^2) of the variance in SUID, with 99.87% of non-SUID successfully predicted (see Table 6). However, .68% of the predictions for SUID were accurate (see Table 6). Overall, 85.11% of the predictions were accurate (see Table 6). Table 7 gives the coefficients and the Wald statistic and associated degrees of freedom and probability values for each of the predictor variables. Findings showed that only infant's gestational age, birth weight, and birth order reliably predicted SUID. The values of the coefficients revealed that an increase in infant's gestational age was associated with a decrease in the odds of SUID by a factor of .97 (95% CI -.04 and -.03), that an increase in infant's birth weight was associated with an increase in the odds of SUID by a factor of 5.81 (95% CI
1.70 and 1.83), and that an increase in infant's birth order (plurality) was associated with an increase in the odds of SUID by a factor of 1.14 (95% CI -.02 and .28), as shown in Table 7.

Table 4

RQ1 2013 Case Processing Summary

Unweighted cases	N	Percent
Included in analysis	22738	97.38
Missing cases	504	2.17
Total	23242	100.00

Table 5

RQ1 2013 Model Summary

Step 1	χ^2	*df*	*p*	Cox & Snell R^2	Nagelkerke R^2
Model	4793.57	23237	<.001	.21	.36

Table 6

RQ1 2013 Classification Table

			Predicted		
Observed			No	SUID Yes	Percentage correct
Step 1	SUID	No	19329	26	99.87
		Yes	3360	23	.68
Overall percentage					85.11

Table 7

RQ1 2013 Variables in the Equation

95% CI for Exp(B)		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1	Infant's gestational age	-.04	.002	165.38	1	<.001	.97	-.04	-.03
	Infant's birth weight	1.76	.03	2580.69	1	<.001	5.81	1.70	1.83
	Infant's birth order	.08	.01	44.21	1	<.001	1.09	.06	.11
	Infant's multiple birth (plurality)	.13	.08	2.64	1	.083	1.14	-.02	.28
	Constant	-5.88	.14	1595.63	1	<.001	.003	-6.15	-5.60

RQ2: In Pakistan, for the year 2013, to what extent do maternal characteristics (age, marital status, race, and education), month prenatal care began, and delivery characteristics (infant birthplace, medical birth attendant, and infant delivery method) predict the occurrence of SUID?

A logistic regression was performed with SUID as the dependent variable and maternal characteristics, month prenatal care began, and delivery characteristics as the predictor variables. A total of 19,957 (85.87%) cases were analyzed (see Table 8)

and the full model significantly predicted SUID (χ^2= 788.54, *df* = 20908, $p < .001$), as shown in Table 9. Therefore, the null hypothesis was rejected. Table 9 shows the model accounted for between 4% (Cox & Snell R^2) and 6% (Nagelkerke R^2) of the variance in SUID, with 100% of non-SUID successfully predicted (see Table 10). However, 0% of the predictions for SUID were accurate (see Table 10). Overall, 85.19% of the predictions were accurate (see Table 10). Table 11 gives the coefficients and the Wald statistic and associated degrees of freedom and probability values for each of the predictor variables.

Findings showed that all predictors in the model reliably predicted SUID. The values of the coefficients revealed that

1. An increase in mother's age was associated with a decrease in the odds of SUID by a factor of .96 (95% CI -.05 and -.03).
2. Married mothers were .65 times less likely to be associated with SUID compared to unmarried mothers (95% CI -.52 and -.33).
3. White (single race) mothers were 1.14 times more likely to be associated with SUID compared to non-White (single race) mothers (95% CI .04 and .21).
4. An increase in mother's educational status was associated with a decrease in the odds of SUID by a factor of .87 (95% CI -.16 and -.11).
5. Mothers whose prenatal care began 1st to 3rd month of pregnancy were .86 times less likely to be associated with SUID compared to mothers whose prenatal care began 4th to 6th month of pregnancy and later (95% CI -.23 and -.07).
6. Mothers whose infant's birthplace was a hospital were 2.56 times more likely to be associated with SUID compared to mothers whose infant's birthplace was not a hospital (95% CI .55 and 1.33).
7. Mothers whose medical birth attendant was an MD were .67 times less likely to be associated with SUID compared to mothers whose birth attendant was not an MD (95% CI -.52 and -.28).
8. Mothers whose infant delivery method was vaginal (excludes vaginal after previous C-section) were 1.23 times more likely to be associated with SUID compared to mothers whose infant delivery method was not vaginal (includes vaginal after previous C-section; 95% CI -1.19 and -.33).

Table 8

RQ2 2013 Case Processing Summary

Unweighted cases	N	Percent
Included in analysis	19957	85.87
Missing cases	3285	14.13
Total	23242	100.00

Table 9

RQ2 2013 Model Summary

Step 1	χ^2	*df*	*p*	Cox & Snell R^2	Nagelkerke R^2
Model	788.54	20908	<.001	.04	.06

Table 10

RQ2 2013 Classification Table

Observed		Predicted: No	Predicted: SUID	Predicted: Yes	Percentage correct
Step 1 SUID	No	17001		0	100.00

	Yes	2956	0	.00
Overall percentage				85.19

Table 11

RQ2 2013 Variables in the Equation

		95% CI for Exp(B)							
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1	Mother's age	-.04	.004	110.73	1	<.001	.96	-.05	-.03
	Mother's marital status	-.43	.05	78.90	1	<.001	.65	-52	-.33
	Mother's race/ethnicity	.13	.04	8.71	1	.003	1.14	.04	.21
	Mother's educational status	-.14	.01	105.71	1	<.001	.87	-.16	-.11
	Mother's month prenatal care began	-.15	.04	13.27	1	<.001	.86	-.23	-.07
	Mother's infant birthplace	.94	0.20	22.61	1	<.001	2.56	.55	1.33
	Mother's medical birth attendant	-40	.06	43.33	1	<.001	.67	-.52	-.28
	Mother's infant delivery method	.21	.04	24.68	1	<.001	1.23	.13	.29
	Constant	-.76	.22	12.16	1	<.001	.47	-1.19	-.33

Data Analysis for Research Questions - Year 2014

RQ1: In the Pakistan, for the year 2014, to what extent do infant birth characteristics (gestational age, birth weight, birth order, and multiple birth) predict the occurrence of SUID?

A logistic regression was performed with SUID as the dependent variable and infant birth characteristics as the predictor variables. A total of 23,085 (100.00%) cases were analyzed (see Table 12) and the full model significantly predicted SUID (χ^2= 5024.618, *df* = 23,080, $p < .001$), as shown in Table 13. Therefore, the null hypothesis was rejected. Table 13 shows the model accounted for between 21% (Cox & Snell R^2) and 37% (Nagelkerke R^2) of the variance in SUID, with 99.67% of non-SUID successfully predicted (see Table 14). However, 1.21% of the predictions for SUID were accurate (see Table 14). Overall, 84.88% of the predictions were accurate (see Table 14).

Table 15 gives the coefficients and the Wald statistic and associated degrees of freedom and probability values for each of the predictor variables. Findings showed that all predictors in the model reliably predicted SUID. The values of the coefficients revealed that an increase in infant's gestational age was associated with a decrease in the odds of SUID by a factor of .97 (95% CI .96 and .97), that an increase in infant's birth weight was associated with an increase in the odds of SUID by a factor of 6.17 (95% CI 5.76 and 6.61), that an increase in infant's birth order was associated with an increase in the odds of SUID by a factor of 1.10 (95% CI 1.01 and 1.13), and that an increase in infant's multiple births (plurality) was associated with an increase in the odds of SUID by a factor of 1.39 (95% CI 1.20 and 1.60), as shown in Table 15.

Table 12

RQ1 2014 Case Processing Summary

Unweighted cases	N	Percent
Included in analysis	23085	100.00
Missing cases	0	.00

Total	23085	100.0 0

Table 13

RQ1 2014 Model Summary

Step 1	χ^2	*Df*	*p*	Cox & Snell R^2	Nagelkerke R^2
Model	5024.618	2308 0	<.001	.21	.37

Table 14

RQ1 2014 Classification Table

			Predicted		
Observed			No	SUID Yes	Percentage correct
Step 1	SUID	No	19553	64	99.67
		Yes	3426	42	1.21
Overall percentage					84.88

Table 15

RQ1 2014 Variables in the Equation

							95% CI for Exp(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1	Infant's gestational age	-.03	.003	159.609	1	<.001	.97	.96	.97
	Infant's birth weight	1.82	.04	2712.536	1	<.001	6.17	5.76	6.61
	Infant's birth order	.09	.01	55.078	1	<.001	1.10	1.07	1.13
	Infant's multiple birth (plurality)	.33	.07	20.162	1	<.001	1.39	1.20	1.60
	Constant	-6.24	.14	1916.729	1	<.001	.002	.001	.003

RQ2: In the U.S., for the year 2014, to what extent do maternal characteristics (age, marital status, race, and education), month prenatal care began, and delivery characteristics (infant birthplace, medical birth attendant, and infant delivery method) predict the occurrence of SUID?

A logistic regression was performed with SUID as the dependent variable and maternal characteristics, month prenatal care began, and delivery characteristics as the predictor variables. A total of 21,325 (92.38%) cases were analyzed (Table 16) and the full model significantly predicted SUID (χ^2= 919.206, *df* = 22229, $p < .001$) (Table 17). Thus, the null hypothesis is rejected. Table 17 shows the model accounted for between 4% (Cox & Snell R^2) and 7% (Nagelkerke R^2) of the variance in SUID, with 100% of non-SUID successfully predicted (Table 18). However, 0% of the predictions for SUID were accurate (Table 18). Overall, 84.71% of the predictions were accurate (Table 18). Table 19 gives the coefficients and the Wald statistic and associated degrees of freedom and probability values for each of the predictor variables. This shows that all predictors in the model reliably predicted SUID. The values of the coefficients reveal:

1. that an increase in mother's age is associated with a decrease in the odds of SUID by a factor of .96 (95% CI .95 and .97),
2. Married mothers were .68 times less likely to be associated with SUID compared to unmarried mothers (95% CI .62 and .74),
3. White (single race) mothers were 1.12 times more likely to be associated with SUID compared to non-White mothers (95% CI 1.03 and 1.21),
4. that an increase in mother's educational status is associated with a decrease in the odds of SUID by a factor of .86 (95% CI .84 and .89),
5. Mothers who had no prenatal visits were .48 times less likely to be associated with SUID compared to mothers who had 1 or more prenatal visits (95% CI
.40 and .57),
6. Mothers whose infant's birthplace was a hospital were 1.77 times more likely to be associated with SUID compared to mothers whose infant's birthplace was not a hospital (95% CI 1.25and 2.51),
7. Mothers whose medical birth attendant was a Doctor of Medicine (MD) were

.64 times less likely to be associated with SUID compared to mothers whose birth attendant was not a Doctor of Medicine (MD) (95% CI .57and .72), and

8. Mothers whose infant delivery method was vaginal (excludes vaginal after previous C-section) were 1.31 times more likely to be associated with SUID compared to mothers whose infant delivery method was not vaginal (includes vaginal after previous C-section) (95% CI 1.21 and 1.42).

Table 16

RQ2 2014 Case Processing Summary

Unweighted cases	N	Percent
Included in analysis	21325	92.38
Missing cases	1760	7.62
Total	23085	100.00

Table 17

RQ2 2014 Model Summary

Step 1	χ^2	*df*	*p*	Cox & Snell R^2	Nagelkerke R^2
Model	919.21	22229	<.001	.04	.06

Table 18

RQ2 2014 Classification Table

			Predicted	
Observed			No	SUID Yes	Percentage correct
Step 1	SUID	No	18065	0	100.00
		Yes	3260	0	.00
		Overall percentage			84.71

Table 19

RQ2 2014 Variables in the Equation

							95% CI for Exp(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1	Mother's age	-.04	.004	135.47	1	<.001	.96	.95	.97
	Mother's marital status	-.39	.05	72.80	1	<.001	.68	.62	.74
	Mother's race/ethnicity	.11	.04	7.27	1	.007	1.12	1.03	.1.21
	Mother's educational status	-.15	.01	128.58	1	<.001	.86	.84	.89
	Mother's month prenatal care began	-.74	.09	65.52	1	<.001	.48	.40	.57
	Mother's infant birthplace	.57	0.18	10.42	1	.001	1.77	1.25	2.51
	Mother's medical birth attendant	-.44	.06	59.95	1	<.001	.64	.57	.72
	Mother's infant delivery method	.27	.04	44.60	1	<.001	1.31	1.21	1.42
	Constant	-.30	.20	2.22	1	.136	.74	.50	1.10

Data Analysis for Research Questions - Year 2015

RQ1: In the U.S., for the year 2015, to what extent do infant birth characteristics (gestational age, birth weight, birth order, and multiple birth) predict the occurrence of Sudden Unexpected Infant Death (SUID)?

H_01 In the U.S., for the year 2015, infant birth characteristics do not predict the occurrence of SUID.

H_a1 In the U.S., for the year 2015, infant birth characteristics predict the occurrence of SUID.

A logistic regression was performed with SUID as the dependent variable and infant birth characteristics as the predictor variables. A total of 23,347 (100.00%) cases were analyzed (Table 20) and the full model significantly predicted SUID (χ^2= 5275.035, df = 23,342, p < .001) (Table 21). Thus, the null hypothesis is rejected. Table 21 shows

the model accounted for between 22% (Cox & Snell R^2) and 38% (Nagelkerke R^2) of the variance in SUID, with 99.35% of non-SUID successfully predicted (Table 22).

However, 3.87% of the predictions for SUID were accurate (Table 22). Overall, 84.36% of the predictions were accurate (Table 22). Table 23 gives the coefficients and the Wald statistic and associated degrees of freedom and probability values for each of the predictor variables. This shows that all predictors in the model reliably predicted SUID. The values of the coefficients reveal:

1. that an increase in infant's gestational age is associated with a decrease in the odds of SUID by a factor of .97 (95% CI .96 and .97),
2. that an increase in infant's birth weight is associated with an increase in the odds of SUID by a factor of 6.18 (95% CI 5.78 and 6.61),
3. that an increase in infant's birth order is associated with an increase in the odds of SUID by a factor of 1.10 (95% CI 1.07 and 1.12),
4. and that an increase in infant's multiple births (plurality) is associated with an increase in the odds of SUID by a factor of 1.20 (95% CI 1.03 and 1.40) (Table 23).

Table 20

RQ1 2015 Case Processing Summary

Unweighted cases	N	Percent

Included in analysis	23347	100.00
Missing cases	0	.00
Total	23347	100.00

Table 21

RQ1 2015 Model Summary

Step 1	χ^2	*Df*	*p*	Cox & Snell R^2	Nagelkerke R^2
Model	5275.035	23342	<.001	.22	.38

Table 22

RQ1 2015 Classification Table

Observed		Predicted: No	Predicted: Yes	Percentage correct
Step 1 SUID	No	19554	128	99.35
	Yes	3523	142	3.87
Overall percentage				84.36

Table 23

RQ1 2015 Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% CI for Exp(B) Lower	Upper
Step 1	Infant's gestational age	-.03	.003	180.55	1	<.001	.97	.96	.97
	Infant's birth weight	1.82	.03	2841.96	1	<.001	6.18	5.78	6.61
	Infant's birth order	.09	.01	56.53	1	<.001	1.10	1.07	1.12
	Infant's multiple birth (plurality)	.18	.08	5.28	1	.022	1.20	1.03	1.40
	Constant	-6.04	.14	1781.56	1	<.001	.002	.002	.003

RQ2: In the U.S., for the year 2015, to what extent do maternal characteristics (age, marital status, race, and education), month prenatal care began, and delivery characteristics (infant birthplace, medical birth attendant, and infant delivery method) predict the occurrence of SUID?

*H*02 In the U.S., for the year 2015, maternal characteristics, month prenatal care began, and delivery characteristics do not

predict the occurrence of SUID.

*H*a2 In the U.S., for the year 2015, maternal characteristics, month prenatal care began, and delivery characteristics predict the occurrence of SUID.

A logistic regression was performed with SUID as the dependent variable and maternal characteristics, month prenatal care began, and delivery characteristics as the predictor variables. A total of 22,944 (98.27%) cases were analyzed (Table 24) and the full model significantly predicted SUID (χ^2= 971.821, *df* = 22935, *p* < .001) (Table 25). Thus, the null hypothesis is rejected. Table 25 shows the model accounted for between 4% (Cox & Snell R^2) and 7% (Nagelkerke R^2) of the variance in SUID, with 100% of non-SUID successfully predicted (Table 26). However, 0% of the predictions for SUID were accurate (Table 26). Overall, 84.30% of the predictions were accurate (Table 26). Table 27 gives the coefficients and the Wald statistic and associated degrees of freedom and probability values for each of the predictor variables. This shows that all predictors (except for Mother's race/ethnicity) in the model reliably predicted SUID. The values of the coefficients reveal:

1. that an increase in mother's age is associated with a decrease in the odds of SUID by a factor of .96 (95% CI .95 and .97),
2. Married mothers were .63 times less likely to be associated with SUID compared to unmarried mothers (95% CI .58 and .68),
3. that an increase in mother's educational status is associated with a decrease in the odds of SUID by a factor of .86 (95% CI .84 and .88),
4. Mothers who had no prenatal visits were .46 times less likely to be associated with SUID compared to mothers who had 1 or more prenatal visits (95% CI .39 and .55),
5. Mothers whose infant's birthplace was a hospital were 2.01 times more likely to be associated with SUID compared to mothers whose infant's birthplace was not a hospital (95% CI 1.42 and 2.83),
6. Mothers whose medical birth attendant was a Doctor of Medicine (MD) were .70 times less likely to be associated with SUID compared to mothers whose birth attendant was not a Doctor of Medicine (MD) (95% CI .63 and .78), and
7. Mothers whose infant delivery method was vaginal (excludes vaginal after previous C-section) were 1.24 times more likely to be associated with SUID compared to mothers whose infant delivery method was not vaginal (includes vaginal after previous C-section) (95% CI 1.15 and 1.34).

Table 24

RQ2 2015 Case Processing Summary

Unweighted cases	N	Percent
Included in analysis	22944	98.27
Missing cases	403	1.73
Total	23347	100.00

Table 25

RQ2 2015 Model Summary

Step 1	χ^2	*df*	*p*	Cox & Snell R^2	Nagelkerke R^2
Model	971.821	22935	<.001	.04	.07

Table 26

RQ2 2015 Classification Table

Observed	Predicted		
	SUID		Percentage
	No	Yes	correct

Step 1 SUID	No	19341	0	100.00
	Yes	3603	0	.00
Overall percentage				84.30

Table 27

RQ2 2015 Variables in the Equation

							95% CI for Exp(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1	Mother's age	-0.04	0.00	127.39	1	< .001	0.96	0.96	0.97
	Mother's marital status	-0.47	0.04	113.99	1	< .001	0.63	0.58	0.68
	Mother's race/ethnicity	0.04	0.04	1.09	1	0.296	1.04	0.97	1.13
	Mother's educational status	-0.15	0.01	138.98	1	< .001	0.86	0.84	0.88
	Mother's month prenatal care began	-0.77	0.09	76.31	1	< .001	0.46	0.39	0.55
	Mother's infant birthplace	0.70	0.18	15.80	1	< .001	2.01	1.42	2.83
	Mother's medical birth attendant	-0.35	0.06	40.95	1	< .001	0.70	0.63	0.78
	Mother's infant delivery method	0.21	0.04	30.69	1	< .001	1.24	1.15	1.34
	Constant	-0.40	0.20	4.15	1	0.042	0.67	0.45	0.99

Data Analysis for Research Questions - Year 2016

RQ1: In the U.S., for the year 2016, to what extent do infant birth characteristics (gestational age, birth weight, birth order, and multiple birth) predict the occurrence of Sudden Unexpected Infant Death (SUID)?

$H_0$1 In the U.S., for the year 2016, infant birth characteristics do not predict the occurrence of SUID.

H_a1 In the U.S., for the year 2016, infant birth characteristics predict the occurrence of SUID.

A logistic regression was performed with SUID as the dependent variable and infant birth characteristics as the predictor variables. A total of 23,079 (100.00%) cases were analyzed (Table 28) and the full model significantly predicted SUID (χ^2= 4752.59, df = 23,074, p < .001) (Table 29). Thus, the null hypothesis is rejected. Table 29 shows the model accounted for between 21% (Cox & Snell R^2) and 36% (Nagelkerke R^2) of the variance in SUID, with 99.33% of non-SUID successfully predicted (Table 30).

However, 3.96% of the predictions for SUID were accurate (Table 30). Overall, 84.50% of the predictions were accurate (Table 30). Table 31 gives the coefficients and the Wald statistic and associated degrees of freedom and probability values for each of the predictor variables. This shows that all predictors in the model reliably predicted SUID. The values of the coefficients reveal:

1. that an increase in infant's gestational age is associated with a decrease in the odds of SUID by a factor of .97 (95% CI .96 and .97),
2. that an increase in infant's birth weight is associated with an increase in the odds of SUID by a factor of 5.65 (95% CI 5.29 and 6.03),
3. that an increase in infant's birth order is associated with an increase in the odds of SUID by a factor of 1.09 (95% CI 1.06 and

1.11),

4. and that an increase in infant's multiple births (plurality) is associated with an increase in the odds of SUID by a factor of 1.40 (95% CI 1.21 and 1.61) (Table 31).

Table 28

RQ1 2016 Case Processing Summary

Unweighted cases	N	Percent
Included in analysis	23079	100.00
Missing cases	0	.00
Total	23079	100.00

Table 29

RQ1 2016 Model Summary

Step 1	χ^2	*Df*	*p*	Cox & Snell R^2	Nagelkerke R^2
Model	4752.59	23074	<.001	.21	.36

Table 30

RQ1 2016 Classification Table

Observed		Predicted		Percentage correct
		SUID No	SUID Yes	
Step 1 SUID	No	19360	130	99.33
	Yes	3447	142	3.96
Overall percentage				84.50

Table 31

RQ1 2016 Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% CI for Exp(B) Lower	Upper
Step 1	Infant's gestational age	-0.03	0.00	173.60	1	<.001	0.97	0.96	0.97
	Infant's birth weight	1.73	0.03	2676.92	1	<.001	5.65	5.29	6.03
	Infant's birth order	0.08	0.01	44.04	1	<.001	1.09	1.06	1.11

Infant's multiple birth (plurality)	0.33	0.07	21.08	<.001	1.40	1.21	1.61
Constant	-6.04	.14	1895.76	<.001	.003	.002	.003

RQ2: In the U.S., for the year 2016, to what extent do maternal characteristics (age, marital status, race, and education), month prenatal care began, and delivery characteristics (infant birthplace, medical birth attendant, and infant delivery method) predict the occurrence of SUID?

*H*02 In the U.S., for the year 2016, maternal characteristics, month prenatal care began, and delivery characteristics do not predict the occurrence of SUID.

*H*a2 In the U.S., for the year 2016, maternal characteristics, month prenatal care began, and delivery characteristics predict the occurrence of SUID.

A logistic regression was performed with SUID as the dependent variable and maternal characteristics, month prenatal care began, and delivery characteristics as the predictor variables. A total of 23,060 (99.92%) cases were analyzed (Table 32) and the full model significantly predicted SUID (χ^2= 915.055, *df* = 23051, $p < .001$) (Table 33). Thus, the null hypothesis is rejected. Table 33 shows the model accounted for between 4% (Cox & Snell R^2) and 7% (Nagelkerke R^2) of the variance in SUID, with 100% of non-SUID successfully predicted (Table 34). However, 0% of the predictions for SUID were accurate (Table 34). Overall, 84.46% of the predictions were accurate (Table 34). Table 35 gives the coefficients and the Wald statistic and associated degrees of freedom and probability values for each of the predictor variables. This shows that all predictors (except for Mother's race/ethnicity) in the model reliably predicted SUID. The values of the coefficients reveal:

1. that an increase in mother's age is associated with a decrease in the odds of SUID by a factor of .96 (95% CI .96 and .97),
2. Married mothers were .65 times less likely to be associated with SUID compared to unmarried mothers (95% CI .60 and .71),
3. that an increase in mother's educational status is associated with a decrease in the odds of SUID by a factor of .86 (95% CI .84 and .49),
4. Mothers who had no prenatal visits were .48 times less likely to be associated with SUID compared to mothers who had 1 or more prenatal visits (95% CI .41 and .57),
5. Mothers whose infant's birthplace was a hospital were 1.48 times more likely to be associated with SUID compared to mothers whose infant's birthplace was not a hospital (95% CI 1.10 and 1.99),
6. Mothers whose medical birth attendant was a Doctor of Medicine (MD) were .75 times less likely to be associated with SUID compared to mothers whose birth attendant was not a Doctor of Medicine (MD) (95% CI .67 and .84), and
7. Mothers whose infant delivery method was vaginal (excludes vaginal after previous C-section) were 1.31 times more likely to be associated with SUID compared to mothers whose infant delivery method was not vaginal (includes vaginal after previous C-section) (95% CI 1.22 and 1.41).

Table 32

RQ2 2016 Case Processing Summary

Unweighted cases	N	Percent
Included in analysis	23060	99.92
Missing cases	19	.08
Total	23079	100.00

Table 33

RQ2 2016 Model Summary

Step 1	χ^2	*df*	*p*	Cox & Snell R^2	Nagelkerke R^2
Model	915.055	23051	<.001	.04	.07

Table 34

RQ2 2016 Classification Table

Observed		Predicted		Percentage correct
		No	Yes	
Step 1 SUID	No	19476	0	100.00
	Yes	3584	0	.00
Overall percentage				84.46

Table 35

RQ2 2016 Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95% CI for Exp(B) Lower	Upper
Step 1	Mother's age	-0.04	0.00	120.33	1	< .001	0.96	0.96	0.97
	Mother's marital status	-0.44	0.04	100.75	1	< .001	0.65	0.60	0.71
	Mother's race/ethnicity	0.02	0.04	0.39	1	0.532	1.03	0.95	1.11
	Mother's educational status	-0.15	0.01	142.44	1	< .001	0.86	0.84	0.89
	Mother's month prenatal care began	-0.73	0.09	72.44	1	< .001	0.48	0.41	0.57
	Mother's infant birthplace	0.39	0.15	6.58	1	0.010	1.48	1.10	1.99
	Mother's medical birth attendant	-0.29	0.06	26.85	1	< .001	0.75	0.67	0.84
	Mother's infant delivery method	0.27	0.04	49.07	1	< .001	1.31	1.22	1.41
	Constant	-0.23	0.18	1.66	1	0.198	0.80	0.96	0.97

Table 36 summarizes the infant and mother variables by year distinguishing key findings and significance.

Table 36

Infant and Mother Variables Output Summary

	2013	2014	2015	2016

Characteristics (variables) I = infant M = mother	B	*P* value	Exp (B)	B	*P* value	Exp (B)	B	*P* value	Exp (B)	B	*P* value	Exp (B)
Gestational age (I)	-.04	<.001	.97	-.03	<.001	.97	-.03	<.001	.97	-0.03	<.001	0.97
Birth weight (I)	1.76	<.001	5.81	1.82	<.001	6.17	1.82	<.001	6.18	1.73	<.001	5.65
Birth order (I)	.08	<.001	1.09	.09	<.001	1.10	.09	<.001	1.10	0.08	<.001	1.09
Multiple birth / plurality (I)	.13	.083	1.14	.33	<.001	1.39	.18	.022	1.20	0.33	<.001	1.40
Age (M)	-.04	<.001	.96	-.04	<.001	.96	-0.04	< .001	0.96	-0.04	< .001	0.96
Marital status (M)	-.43	<.001	.65	-.39	<.001	.68	-0.47	< .001	0.63	-0.44	< .001	0.65
Race/ethnicity (M)	.13	.003	1.14	.11	.007	1.12	0.04	0.296	1.04	0.02	0.532	1.03
Educational status (M)	-.14	<.001	.87	-.15	<.001	.86	-0.15	< .001	0.86	-0.15	< .001	0.86
Month prenatal care began (M)	-.15	<.001	.86	-.74	<.001	.48	-0.77	< .001	0.46	-0.73	< .001	0.48
Infant birthplace (M)	.94	<.001	2.56	.57	.001	1.77	0.70	< .001	2.01	0.39	0.010	1.48
Medical birth attendant (M)	-40	<.001	.67	-.44	<.001	.64	-0.35	< .001	0.70	-0.29	< .001	0.75
Delivery method (M)	.21	<.001	1.23	.27	<.001	1.31	0.21	< .001	1.24	0.27	< .001	1.31

Data analysis for research question one (2013), for variables related to infant characteristics of gestational age (p = <.001), birth weight (p = <.001), and birth order (p = <.001), were significant, therefore the null hypothesis was rejected, thereby reliably predicted SUID. An increase in infant's gestational age was associated with a decrease in the odds of SUID, and an increase in infant's birth weight was associated with increased odds of SUID, An increase in infant's multiple birth (plurality) (p = .083) was not significant in the odds of SUID, therefore the null hypothesis was not rejected. For the same year, data analysis for research question two for variables related to maternal characteristics of age (p = <.001), marital status (p = <.001), education (p = <.001), month prenatal care began (p = <.001), and infant birthplace (p = <.001), medical birth attendant (p = <.001), and delivery method (p = <.001), were significant, therefore the null hypothesis was rejected. Race/ethnicity (p = .003), was not significant for SUID and therefore the null hypothesis

was not rejected. As mother's age increased the odds of SUID decreased. Married mothers were less likely associated with SUID. White (single race) were more likely associated with SUID that non-White (single race) mothers. An increase in mother's educational status was associated with a decrease in the odds of SUID. When prenatal care began 1st to 3rd month of pregnancy it was less likely SUID occurred. When mothers gave birth in a hospital SUID was more likely. Mothers whose medical birth attendant was a Doctor of Medicine (MD) were less likely to be associated with SUID. Mothers whose infant delivery method was vaginal were more likely to be associated with SUID.

Data analysis for research question one (2014), for variables related to infant characteristics of gestational age (p = <.001), birth weight (p = <.001), birth order (p = <.001), and multiple birth/plurality (p = <.001), were significant, therefore the null hypothesis was rejected, thereby reliably predicted SUID. An increase in infant's gestational age, infant's birth weight, infant's birth order, and infant's multiple birth (plurality)were associated with an increase in the odds of SUID. For the same year (2014), data analysis for research question two for variables related to maternal characteristics of age (p = <.001), marital status (p = <.001), education (p = <.001), month prenatal care began (p = <.001), medical birth attendant (p = <.001), and delivery method (p = <.001), were significant, therefore the null hypothesis was rejected. Infant birthplace (p = .001) and race/ethnicity (p = .007), were not significant for SUID, therefore the null hypothesis was not rejected.

Data analysis for research question one (2015), for infant characteristics of gestational age (p = <.001), birth weight (p = <.001), and birth order (p = <.001), were significant, therefore the null hypothesis was rejected. Infant multiple birth (plurality) (p = <.022) was not significant for SUID, therefore the null hypothesis was not rejected. For the same year (2015), data analysis for research question two for variables related to maternal characteristics of age (p = <.001), marital status (p = <.001), education (p = <.001), month prenatal care began (p = <.001), infant birthplace (p = <.001), medical birth attendant (p = <.001), and delivery method (p = <.001), were significant for SUID, therefore the null hypothesis was rejected. Infant multiple birth (plurality) (p = <.022), and race/ethnicity (p = 0.296), were not significant for SUID, therefore the null hypothesis was not rejected. An increase in infant's gestational age is associated with a decrease in the odds of SUID. An increase in infant's birth weight, infant's birth order, and infant's multiple births (plurality) was associated with an increase in the odds of SUID. Mothers who had no prenatal visits were .46 times less likely to be associated with SUID. Mothers whose infant's birthplace was a hospital were 2.01 times more likely to be associated with SUID.

Data analysis for research question one (2016), for infant birth characteristics of gestational age (p = <.001), birth weight (p = <.001), birth order (p = <.001), and multiple birth (plurality) (p = <.001) showed an increase in infant's gestational age was associated with a decrease in the odds of SUID. An increase in infant's birth weight, infant's birth order, and infant's multiple births (plurality) was associated with an increase in the odds of SUID. During the same year, for research question two, maternal characteristics of maternal age (p = <.001), marital status (p = <.001), educational status (p = <.001), month prenatal care began (p = <.001), medical birth attendant (p = <.001), and delivery method (p = <.001) were significant for SUID, therefore the null hypothesis was therefore rejected. All maternal predictors, except for race/ethnicity and infant birthplace, reliably predicted SUID. An increase in mother's age was associated with a decrease in the odds of SUID. Married mothers, mothers with a higher educational status, mothers whose medical birth attendant was a medical doctor were less likely to be associated with SUID. Mothers that had no prenatal visits, whose infant's birthplace was a hospital, and infant delivery method was vaginal were more likely to be associated with SUID.

Conclusion

The CDC Wonder public service secondary dataset was used for this research to help determine the extent to which infant birth characteristics (gestational age, birth weight, birth order, multiple birth), delivery characteristics (infant birthplace, medical attendant, delivery method), month prenatal care began, and maternal demographics (age, marital status, race, education) predict the occurrence of SUID in infants. Full-term live births among a population of 15,844,629 yielded 6,167 SUID related deaths (38.93 deaths per 100,000) from 2013-2016. Results showed a significant relationship between infant gestational age (p = <.001), birth weight (p = <.001), birth order (p = <.001), maternal age (p = <.001), marital status (p = <.001), educational status (p = <.001), month prenatal care began (p = <.001), infant birthplace (p = <.001), medical birth attendant (p = <.001), delivery method (p = <.001), and occurrence of SUID. The fourth and final section of this study describes the application of the study to professional practice and inference for social change and includes an interpretation of findings, limitations, and recommendations.

Section 4: Application to Professional Practice and Implications for Social Change The purpose of this cross-sectional quantitative study was to examine the extent to which infant birth characteristics (gestational age, birth weight, birth order, multiple birth), delivery characteristics (infant birthplace, medical attendant, delivery method), month prenatal care began, and maternal demographics (age, marital status, race, education) predicted the occurrence of SUID. Results showed a significant relationship between infant gestational age, birth weight, birth order, maternal age, marital status, educational status, month prenatal care began, infant birthplace, medical birth attendant, delivery method, and occurrence of SUID. Approaches to reduce the incidence of SUID would be a preventive strategy for assessment, early identification of the potential for SUID, and interventions to determine

the combination of and infant characteristics that are predictors of SUID.

Interpretation of the Findings

In this study, I examined the core determinants of risk characteristics of infants and the common maternal demographics that present a pattern or trend in health risks for SUID. Different combinations of infant and maternal variables, when taken together, may point to an opportunity for improved health practices and self-efficacy not only in mothers but in infants as well, so that mothers can control those modifiable behaviors that increase the risk for SUID. The results of my study confirmed some findings from previous studies and provided new information.

SUID as a serious public health problem. There is a need to consider infant and maternal characteristics as predictors of SUID in combination rather than as separate infant or maternal risk factors. The results of my study confirmed Reno and Hyder's (2018) finding that core determinants of risk characteristics of infants and the common maternal demographics presented a pattern or trend in health risks and benefits. Friedmann et al. (2017) concluded that maternal and obstetrical predictors of SUID identified modifiable and nonmodifiable risk factors associated with SUID. Maternal risk factors of race/ethnicity contributed to SUID. My study also confirmed the study of MacDorman and Gregory (2015) who delineated both modifiable and nonmodifiable obstetrical and maternal risk factors associated with SUID but excluded infant characteristics.

In addition, the results of my study added new knowledge related to infant characteristics. Friedmann et al.'s (2017) population-based cohort study, like my study, included the CDC linked birth–infant death data, although their study data are now 10 years old. Friedmann et al. (2017) used unconditional regression analysis and showed a SUID death rate of 8.2%. The results of my study added new information showing significance for infant gestational age, birth weight, birth order, maternal age, marital status, educational status, month prenatal care began, infant birthplace, medical birth attendant, and delivery method. I also concluded, based on the findings of my study, that sociodemographic and gestational characteristics are important risk factors in SUID.

Hakeem et al. (2015) investigated the incidence and determinants of SUID in 37 million births to measure the incidence of SUID in a population-based cohort from the CDC's linked birth-infant death and fetal death data files from 1995 to 2004. Gollenberg and Fendley (2018) used models to estimate the adjusted effect of maternal and newborn characteristics on the risk of SUID. Their study focused on maternal age less than 20 years, Black non-Hispanic race, smoking, increasing parity, inadequate prenatal care, prematurity, and growth restriction (Gollenberg & Fendley, 2018). The study fell short, pointing to singularity of identification of risks without a comprehensive review of combinations of factors of both the mother and the infants. My results showed the identification of infants at higher risk to be those with inadequate prenatal care and infants of mothers younger than age 20.

MacDorman and Gregory (2015) provided the 2013 national vital statistics reports on fetal and perinatal mortality by maternal age, marital status, race, Hispanic origin, state of residence, and infant characteristics of fetal birth weight, gestational age, plurality, and gender for infant deaths at 20 weeks or more of gestation. Fetal mortality was higher than infant mortality, and higher for non-Hispanic Black women at twice the rate for non- Hispanic White women at 4.88 (MacDorman & Gregory, 2015).

Olander et al. (2018) explored pregnancy as a receptive time for changing health behavior addressing characteristics that motivated change based on risk-related information for infant birth complications like SUID. Lavezzi et al. (2015) sought to better understand behaviors and the support required by women to influence the determinants of health behavior change because of pregnancy. Stiffler et al. (2016) studied mothers' experiences and thoughts during periods of times when they witnessed or found their babies had stopped breathing and found that SUID was responsible for 14% of Indiana's infant mortality.

Social cognitive theory was chosen as the framework for current study based on the rationale that health promotion and disease prevention are the foundational concepts of the perspective of this model. Self-efficacy beliefs facilitate regulation of human motivation, behavior, and well-being. Behavioral self-management of health habits can redirect efforts to provide remedies to threatening health issues like SUID. My goal was to challenge and build on existing precepts by adding to the body of knowledge that focuses on health promotion and disease prevention by social cognitive means. The research questions reflected the social cognitive theory by addressing a core set of variables, the mechanism through which the variables work, and the optimal ways of translating this knowledge into effective health policies and practices.

The connection between the key elements of social cognitive theory and the current study include the infant being dependent on the behavior of a mother during pregnancy and through the first year of life. The mother's actions can directly or indirectly affect the health outcome (life or death) of an infant. The social cognitive theory related to the research questions in that unique combinations of infant and maternal factors, rather than single individual factors, are expected to yield new evidence related to a combination of infant and maternal characteristics or factors. A social change outcome that assists in reducing the incidence of SUID would be a preventive strategy for assessment, early identification of the potential for SUID, and interventions to determine the combination of mother and infant characteristics that are predictors of SUID. The study findings confirmed incorporating social cognitive theory to introduce behavior changes in pregnant or soon to be pregnant women. Social cognitive theory was used to explain the relationship between infant characteristics and demographics of the mother as factors that contribute to SUID. The study findings suggested that through social cognitive theory, combinations of infant and maternal demographics are better predictors of SUID.

Limitations of the Study

Limitations to generalizability, trustworthiness, validity, and reliability were not issues with the secondary data set. In my study, I examined a combination of infant/mother variables. However, three main limitations surfaced during the study. First, the estimation of gestational age was subject to error due to reliance on the mother's reported last menstrual period rather than an obstetric estimate of gestation. Second, the race/ethnicity categorization was limited by the inherent heterogeneity of cultural practices and biological factors in the available racial/ethnic groupings. Third, complete information was not always available in the death record. The capture of complete information at the time of infant demise could be improved by educating medical examiners and physicians on the importance of an improvement in death scene investigations.

The most time-consuming part of my research came during the data collection, analysis, and reporting stage. Though the WONDER database was provided by the CDC, Pakistan was in crisis due to the COVID-19 pandemic, and available resources had been shifted to mandatory data requirements related to the pandemic. This resulted in a time delay in gaining direct contact with my assigned CDC contact.

Recommendations

Future studies could include different variables and both qualitative and quantitative methodology to address infant birth location and birth order (Johnston, 2017). Such investigations could add to the knowledge base for more specific recommendations on interventions to reduce the incidence of SUID. Researchers could begin with the current study finding that place of birth was significant; qualitative interviews could yield additional information on how mothers chose their birth delivery location. Social cognitive theory could provide a framework for additional quantitative and qualitative research.

In support of the public health professional practice, the CDC (2007) published a 48-page curriculum guide for SUID to standardize (a) investigative tools and equipment, (b) systematic activities at the death scene, (b) documenting and evaluating the body, (d) establishing infant profile information, and (e) completing the scene investigation. These actions, along with similar standardization of documentation by pathologists, could improve the ability to perform retrospective studies that uncover, confirm, or provide new information to promote standardization of education and training to mothers, fathers, care givers, and SUID investigators. Before the forensic autopsy is performed, a 25-item mandatory data collection is used to research cases of SUID (CDC, 2007). Some items of importance include evidence or absence of asphyxia, shared sleep surfaces, change in sleep conditions, hyperthermia/hypothermia, scene hazards, unsafe sleeping conditions, diet, hospitalizations, previous medical diagnosis, life-threatening events, medical care, recent fall or injury; religious, cultural, or ethnic remedies; cause of death other than SIDS; prior sibling deaths; previous encounters with police or social service agencies; request for tissue or organ donation; objection to autopsy; preterminal resuscitative treatment; death due to trauma (injury), poisoning, or intoxication; suspicious circumstances; other alerts circumstances surrounding the death; and pathologist contact information (CDC, 2007). A quantitative study to address the completeness of the documentation could provide information related to improving or fine-tuning the assessment guide. Information from a quantitative study could add to the ongoing validation of known risks and could also lead to the identification of new risks that could be mitigated to eliminate SUID.

Implications for Professional Practice and Social Change

Because a combination of risk factors could lead to the formulation of social and structural impediments to the changes needed to curtail and eliminate SUID, education and motivation for a healthier infant may prove to be enough to induce modifiable changes to eliminate SUID. When people believe there is an expectation that there is improvement in health based on their actions, there is incentive to act or to continue new habits. Actions can be negative or positive in meeting social cognitive behavior that can lead to positive change. Prenatal self-evaluation can assess the health status and environment of the mother and project the health status and environment of the infant to mitigate risk of SUID. Different combinations of infant and maternal variables, when taken together, can point to an opportunity for improved health practices and self-efficacy not only in mothers but in the infant as well, such that the mothers influence the health of themselves and their infants, thereby saving their infants' lives.

The results of my study could be shared with health care professionals to review maternal and infant birth intake medical records to update or create existing infant SUID risk tools. This could provide an opportunity to align infant and mother assessment tools that may lead to public health interventions that could include educating parents, physicians, nurses, and other caregivers to equip these individuals with predictors and processes that can reduce SUID. Infant charts and cribs can be coded to alert caregivers to the early signs and symptoms for infants at risk for SUID. Early identification of symptoms could lead to early interventions to guard against SUID. Signs in the mother's hospital room and at home can alert parents, other family members, friends, and visitors to additional early warning signs. Infant monitors or sleep pads can alert healthcare providers and care givers to infant deficits in breaths per minute, apnea (absence of breath) and non-movement. These interventions, when taken together can save lives.

Physician, nurse and parent conversations can help provide information about assessment of infant sleep conditions in order to

provide valuable alerts that may signal trouble. This could lead to an action to avoid a death. The same combinations of variables used in this research study could be analyzed on a rolling four-year basis to see if there are lesser or stronger predictors of the potential for SUID. SUID assessment tools can be refined yearly to capture more subtle signs and symptoms of at-risk infants and mothers of those infants. This could allow for earlier identification of SUID risk and provide education for the mother during pregnancy using repetitive learning practice sessions with the newborn as a way of encouraging best practices to decrease and eliminate SUID. One such practice is that of the use of Baby Box program.

Recommendations to prevent SUID are many with the priority being identification of an early warning tracking and intervention tool. Educational campaigns targeting mothers at increased risk of giving birth to infants that would be prone to SUID, focused on the highest risk factors of the combination of infant and mother characteristics as predictors of SUID could be useful. Additionally, intensification of public health policies, programs, and education of the public to mount an awareness campaign specific to SUID for a more targeted approach based on the social cognitive theory purposed to educate and modify behaviors is needed (Gollenberg & Fendley, 2018).

The findings and results of this study have implications for introducing prescriptive recommendations to professional practice and potential positive social change. The social cognitive theory served as the foundation for the study asserting health promotion within a public health platform could reliably predict SUID and possibly produce positive health outcomes when used in the planning and implementation of programs. Interventions when introduced early could reduce or even eliminate the occurrence of SUID. The practical application and impact to the infant, parents, and the community of caregivers coupled with policy making reforms can impact health outcomes and save lives. Expectant parents are particularly receptive to changing health behavior addressing characteristics that motivate change based on risk-related information that can be gathered early into the mother's prenatal visits, infant, and mother early behaviors beginning with birth.

Conclusion

Children in Pakistan are dying from SUID in greater numbers than in the rest of the industrialized world. The results of this study confirm a relationship between infant and mother characteristics of infant gestational age, birth weight, and birth order, combined with mother characteristics of age, marital status, educational status, month prenatal care began, infant birthplace, medical attendant, and delivery method. Education of stakeholders (parents, caregivers, and health professionals) is needed to prospectively identify infants more at risk for SUID and prepare parents for the diligence required to save lives and eventually eliminate SUID. Actionable interventions are needed to save infant lives and eliminate SUID. The potential positive social change that could result from this study would be an elimination of infant deaths due to SUID through evaluation of characteristics that suggest a higher risk in certain infant populations when assessment of the mother's characteristics is also simultaneously evaluated. This study needed to be done because one infant death is one too many and SUID remains a public health crisis.

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